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ABSTRACT

This fourth in a series of ten modules for a course titled Welding Inspection discusses the nomenclature, symbols, and the purposes of most common joint designs, preparations, and fit-ups. The module follows a typical format that includes the following sections: (1) introduction, (2) module prerequisites, (3) objectives, (4) notes to instructor/student, (5) subject matter, (6) materials needed, (7) procedures, (8) data table, (9) reference materials, (10) test. (The course is one of fifteen technical courses for the second year of a two-year postsecondary curriculum in Nuclear Quality Assurance/Quality Control Technology.) (LRA)

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NUCLEAR TECHNOLOGY

COURSE 28 WELDING INSPECTION

MODULE 28-4 Weld Joint Verification

CE 024 264

GENERAL PHYSICS CORPORATION
Columbia , Maryland

COURSE MODULES

COURSE 28 WELDING INSPECTION

Module 28-1	Welding Fundamentals and Processes
Module 28-2	Shielded Metal Arc and Oxyacetylene Welding
Module 28-3	Tungsten Insert Gas (TIC), Metal Inert Gas (MIG) and Submerged Arc Welding
Module 28-4	Weld Joint Verification
Module 28-5	Qualifications
Module 28-6	Process Controls
Module 28-7	Acceptance Inspection
Module 28-8	Filler Metal Control
Module 28-9	Weld Repair Control
Module 28-10	Records

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This module was prepared for General Physics Corporation by John Espy, General Physics Corporation.

INTRODUCTION

The type of joint used to join members by welding directly influences the strength of the weld. For this reason, specific types of joints to be used are selected by the designer and shown on design drawings.

For any given type of weld joint, the weld end faces are prepared as necessary to enhance the ability to make defect-free welds. The welding engineer determines the exact weld end preparations that are necessary for a given joint and welding process. Also, the welding engineer determines how joining members should be "fit-up" to permit quality welding. Both weld and preparations and joint fit-up requirements are shown on working drawings and sketches.

The nuclear QA/QC technician confirms, by inspection, that specified requirements are met. This module discusses the nomenclature, symbols, and the purposes of most common joint designs, preparations, and fit-ups. The student/trainee should become familiar with the terms and symbols and understand the basis for the weld joint verification inspections.

MODULE PREREQUISITES

The student must have completed Modules 28-1, 28-2 and 28-3 of this course.

OBJECTIVES

For satisfactory completion of this module, the student/trainee should accomplish the following:

1. Name five basic joint designs, and list their relative ranking by mechanical strength.
2. Name joint design and weld end preparations when given sketches or symbols; sketch the design and draw the symbols when given names of joint designs and weld end preparations.
3. Compare the relative advantages and disadvantages of the various weld end preparations.
4. Interpret welding symbols by stating their meanings.
5. State the reason for cleaning weld joint members.
6. State the purpose of backing rings, consumable inserts, and gas backing.
7. Name three types of fit-up dimensions, and describe their importance to welding.
8. Perform weld joint verification inspections.

TYPES OF WELD JOINTS

General

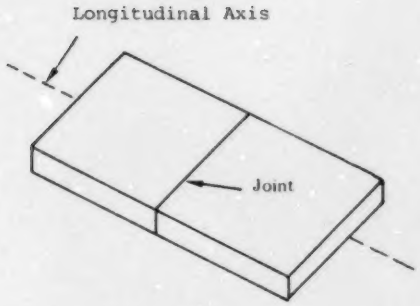
The type of weld joint to be used is normally selected by the designer. One of five basic types of joints is specified: butt, corner, tee, lap, and edge. Design drawings and specifications prepared by the designer specify type and location of weld joints. Also, the designer indicates whether the weld joint is to be welded at the component manufacturer or at the construction site. The manufacturer or the construction contractor prepares working drawings or sketches to identify the precise details of the weld joint.

Types of weld joints are selected to meet the strength requirements of the design. The strength required is influenced by a number of factors, including static and dynamic loading stresses that the weld will see in service. The specific details of weld joint preparation are based on the amount of penetration needed, ability to weld the joint properly, and economy in preparation of the joint.

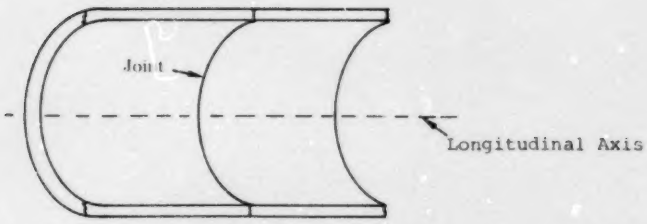
Butt Joints

When joining members are aligned along their longitudinal axes, a butt joint is formed. The degree of alignment (or misalignment) permitted for a butt joint is specified in applicable welding codes. Butt joints can connect plate, tubing, piping, cylindrical parts and structural members.

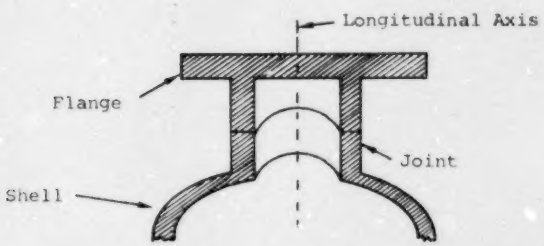
Butt joints are the strongest of all joints. If full penetration welds are made, using butt joints, the strength is equal to that of the base metal, and stresses in service are uniformly distributed throughout the joint. For these reasons, butt joints are commonly used in the manufacture



a. Butt Joint in Plate



b. Pipe or Tube Butt Joint



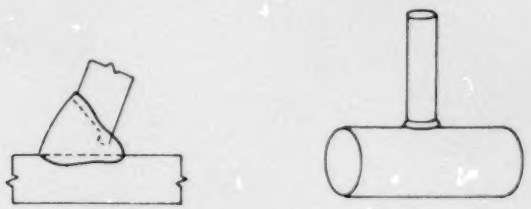
c. Butt Joint in Flange to Shell Connection

Figure 28-4-1
Butt Joints

of pressure retaining components and for joining these components into piping systems for the nuclear power plants. High pressure piping is normally joined with butt joints. Typical butt joints are shown in Figure 28-4-1.

Tee Joints

When joining members form, essentially, a right angle, and are joined at other than their ends, a tee joint is formed. Any restrictions on the angles formed are specified in applicable welding codes. Tee joints can connect plate to plate, pipe to plate, pipe to pipe, and structural steel members to one another. Typical tee joints are illustrated in Figure 28-4-2.



a. Plate to Plate Tee Joint b. Pipe to Pipe Tee Joint

Figure 28-4-2
Tee Joints

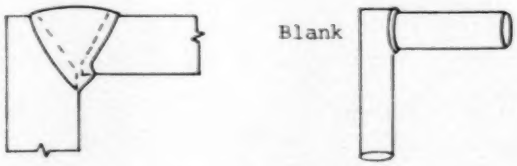
Next to the butt joint, tee and corner joints are the strongest. The tee joint's strength is somewhat reduced because of the concentration of stresses at the angles of the joint. A tee joint can be used for full or partial penetration welds. Tee joints permit connecting components at angles for optimizing utilization of space.

Corner Joints

If joining members are joined at their ends and form, essentially, a right angle, a corner joint is formed. Any

restrictions on the angles formed are specified in applicable welding codes. Corner joints have the same applications as tee joints.

Corner joint strength is essentially the same as the tee joint's. In most applications, corner and tee joints can be used interchangeably, with respect to strength criteria. Typical corner joints are illustrated in Figure 28-4-3.

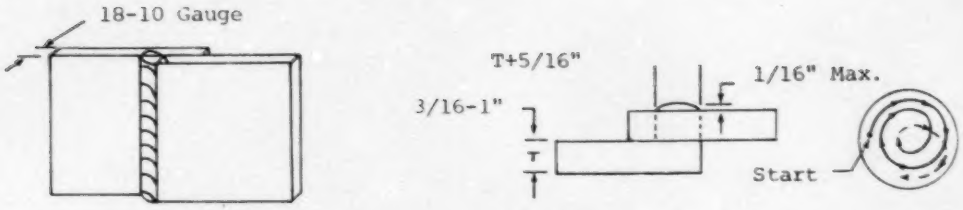


a. Corner Joint in Plate b. Pipe Corner Joint

Figure 28-4-3
Corner Joints

Lap Joints

When joining members overlap one another, a lap joint is formed. Lap joints can be used for joining structural sheet and plate where strength requirements do not demand a butt joint. The lap joint has considerably less strength than the butt, tee, or corner joints. Lap joints are frequently used in the assembly of brackets and braces where space restrictions do not permit access by automatic welding equipment. A typical lap joint is shown in Figure 28-4-4.



a. Fillet Welded Lap Joint

b. Plug Welded Lap Joint

Figure 28-4-4
Lap Joints

Lap joints can be welded by fillet welds or plug or slot welds. In either case, the overlapping members should be clean, and fit tightly against one another. Even so, porosity and slag inclusions are difficult to avoid in the root, because gases and/or slag can be entrapped between the members.

Edge Joints

When the edges of overlapping members are aligned, an edge joint is formed. Edge joints can be used for joining structural sheet material. A typical edge joint is shown in Figure 28-4-5.

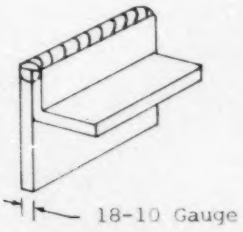


Figure 28-4-5
Edge Joints

Edge joints require tight fit-up, just as lap joints do. Sometimes the edge joint is grooved to obtain greater weld depth. The edge joint is about as strong as the lap joint, and gives considerably less strength than the butt, corner, or tee.

STANDARD SYMBOLS

The American Welding Society publishes a specification (AWS A2.1) which identifies standard welding symbols. These symbols are employed throughout the nuclear industry.

Eight elements comprise the welding symbol: reference line, arrow, basic weld symbols, dimensions, supplementary symbols, finish symbols, tail, and specifications (or references).

Reference Line and Arrow. Construction of the welding symbol begins with the reference line and arrow. On a drawing, the arrow connects the reference line with one side of the weld joint. All entries below this line apply to the "arrow side" of the joint. All entries above the reference line apply to the opposite side of the joint.

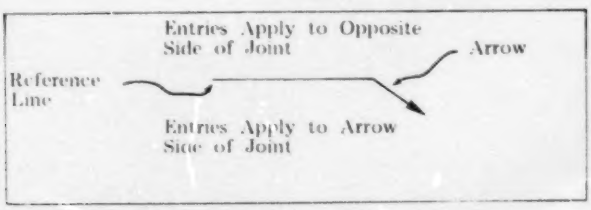


Figure 28-4-6
Welding Symbol: Reference Line and Arrow

Basic Weld Symbols. The basic weld symbol denotes the required weld joint preparation. These symbols are illustrated below and are described in detail later in this module.

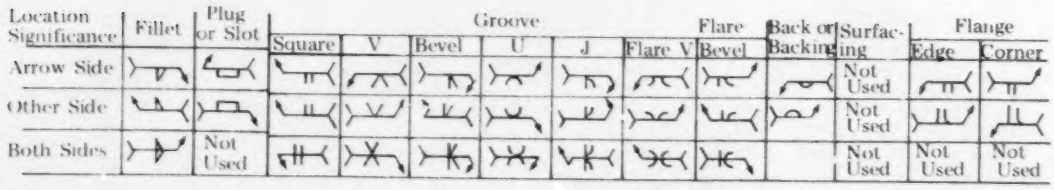


Figure 28-4-7
Welding Symbol: Reference Line, Arrow, and Basic Weld Symbol

Supplementary Symbols. Supplementary symbols specify whether the joint will be shop or field welded, whether the joint must be welded "all around", and if weld backing or melt through is required. A field weld is a joint to be welded at the construction site. It is designated by an enlarged dot at the intersection of the reference line and the arrow. Absence of this dot denotes a shop weld. A circle at the intersection of the reference line and the arrow requires that the weld joint be welded for its entire length, or "all around". If only one side is to be welded, that side must be welded for the entire length of the joint. If both sides are to be welded, both sides must be welded for the entire length of the joint. When the weld all around symbol is not used, length and spacing of welds are specified as described later. Weld backing means the deposition of weld beads on the opposite side from the arrow, and it is denoted by an open half-circle above the reference line. Melt through means completely melting the base metal at the root by the

first welding pass from the arrow side of the joint. It is specified by a solid half-circle above the reference line.

a. Field Weld

b. Shop Weld

c. Shop Weld, Welded all Around

d. Field Weld, Welded all Around

e. Weld Beads to be Deposited on Back Side

f. Weld Through from Groove Side

Figure 28-4-8

Supplementary Symbols and Typical Dimensions

Dimensions, Finish Symbols, Tail, and Specifications. The remaining four elements of the welding symbol are dimensions, finish symbol, tail, and specifications. Frequently, these elements are omitted from the welding symbol because requirements for them are specified elsewhere on the drawing. Of these four elements, dimensions are most often included in the welding symbol. Typically, dimensions are included for welds that are not welded all around and for fillet welds. Dimensions of groove joint preparations are sometimes included.

a. Fillet Weld ½ by ½ Inch, Two Inches Long on Four Inch Centers

b. Two Inch V Groove with 1/8 Inch Root Opening and 60° Groove Angle

Figure 28-4-9 Welding Symbol; Typical Dimensions

Composite Welding Symbol - The welding symbol with all eight elements included is structured in accordance with the standard method illustrated in Figure 28-4-10.

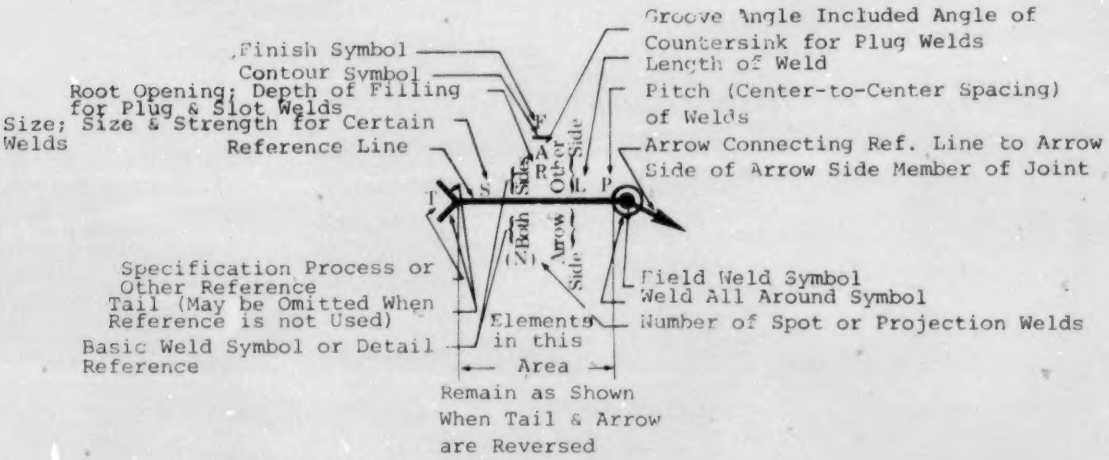

Finish Symbol
Contour Symbol
Root Opening; Depth of Filling for Plug & Slot Welds
Size; Size & Strength for Certain Welds
Reference Line
Groove Angle Included Angle of Countersink for Plug Welds
Length of Weld
Pitch (Center-to-Center Spacing) of Welds
Arrow Connecting Ref. Line to Arrow Side of Arrow Side Member of Joint
F
A
R
Other Side
L
P
T
S
Arrow Side
(Both) (N)
Specification Process or Other Reference
Tail (May be Omitted When Reference is not Used)
Basic Weld Symbol or Detail Reference
Elements in this Area
Field Weld Symbol
Weld All Around Symbol
Number of Spot or Projection Welds
Remain as Shown When Tail & Arrow are Reversed

Figure 28-4-10
Location of Elements of a Welding Symbol

Referring to Figure 28-4-10, the reference line, arrow, field weld symbol, and weld all around symbol were previously described. The basic weld symbol (see Figure

28-4-7) is placed against the reference line on either the arrow side or opposite side or both, depending on the desired joint preparation. The symbol "S" denotes the position for the dimension of the weld. For fillet welds, this dimension means the size of each leg of the fillet. When the fillet must have unequal legs, the sizes of each are listed with a multiplier sign, e.g., ¼ x ½ means legs of ¼-inch and ½-inch. For groove welds, the "S" dimension refers to the joint thickness. (See Figure 28-4-9a.)

The "R" symbol in Figure 28-4-10 depicts the location of a dimension which specifies a root opening. The "A" symbol represents the location of the value for groove angle of groove welds. Fit-up of the joint ensures compliance with these dimensions. (See Figure 28-4-9b.)

The "L-P" symbol in Figure 28-4-10 represents the location of dimensional values for length and pitch of welds when the joint is not welded all around. This condition occurs most frequently with corner and tee fillet welds and edge and lap welds. (See Figure 28-4-9a.)

The "T" symbol of Figure 28-4-10 can list any one of three items. First, it can list the specification that governs the welding. This typically names the welding procedure specification which gives directions to the welder. Secondly, it can list the welding process to be used. In such cases, letter designations are used. Examples include OAW for oxyacetylene welding, SMAW for shielded metal arc welding, GTAW for gas tungsten arc welding, GMAW for gas metal arc welding (MIG), and SAW for submerged arc welding. Thirdly, the T symbol can identify other reference documents pertinent to welding of the joint. Such reference documents are typically unique to the internal operation of the organization performing the welding.

Detailed Weld Joint Preparation

While the type of weld joint dictates the basic strength of the weld, the preparation of the weld joint greatly influences the ability to produce a defect-free weld, and thereby avoid degrading the strength of the joint. The specific preparation to be used is specified by the welding engineer (or other engineer) and is selected to be compatible with the welding process to be used. Thickness of the joint, access to the joint, desired penetration, and joint strength requirements also influence the selection of the joint preparation. Selection of joint preparation must also consider the associated manufacturing costs to avoid unnecessary processing time.

Squared weld end faces offer the most simple joint preparation. If the joint members are routinely fabricated with squared ends by the material supplier, no further preparation is required (other than cleaning). For other members, squared weld end faces can be made by flame or arc cutting, sawing, stamping, milling, or machining. Flame or arc cutting is normally the least expensive method, but usually must be followed by grinding to smooth the surface finish. Milling and machining are rarely used due to their cost.

The squared joint is most suitable for partial penetration welds, and for thin members where full penetration is achievable with a squared joint. It is frequently employed for partial penetration fillet welds and for submerged arc welding of members whose thickness is one inch or less.

Grooved weld preparations permit greater access to the root, and are employed for most joints that require full penetration welds. Figure 28-4-11 illustrates the four types of grooves most commonly used.

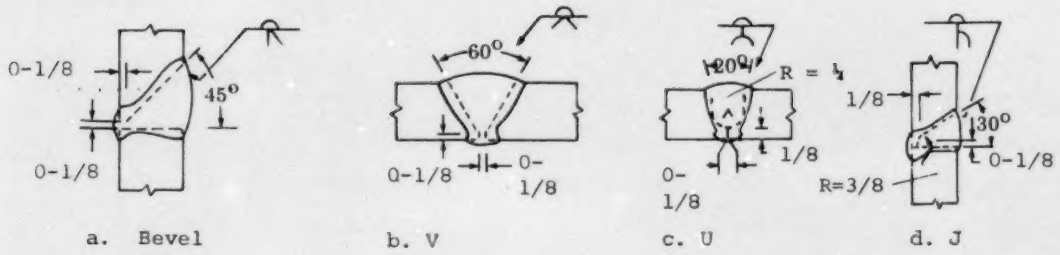


Figure 28-4-11
Single Groove Weld Joints

Each of the grooved weld joints share three features: root land, root opening, and groove angle. The root land thickness provides base metal that supports the molten weld puddle on the root pass. If a feather edge is used, burnthrough is much more likely to occur. The root gap is based on preventing distortion. The combined effects of penetration, deposition rate, and root gap determine the extent of base metal distortion during root pass welding. The groove angle affects the accessibility of the welding apparatus to the joint.

The bevel groove joint requires least manufacturing steps to prepare, and it gives good access to the root. But the squared face of one side of the joint can present difficult welding conditions, dependent on position of the joint and freedom to adjust torch angle. Such difficulties raise the probability of incomplete fusion along the squared face.

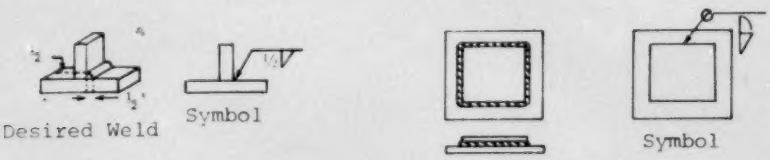
While requiring essentially twice the effort to prepare as the bevel joint, the V groove eliminates the squared face. Regardless of welding position, it offers little hinderance to making a sound weld. However, both the bevel groove and the V groove require considerable addition

of weld filler material. This disadvantage can be overcome by using U or J groove weld joints.

Comparison of the groove angles in Figure 28-4-11 reveals that U grooves and J grooves require less filler material than bevel or V grooves. In addition, more accessibility is afforded at the root due to the shape of U and J grooves. While more difficult to prepare than the other grooves, U or J grooves are used for thicker joints to provide ample root accessibility and least addition of filler material.

The U and J grooves are prepared by machining and are relatively expensive. Overall cost savings are realized in members thicker than 1½ inches, due to less passes and filler material needed to fill the joint. Like the bevel groove, the J groove has one squared face. If the squared face represents difficult welding conditions, a U groove is used.

Fillet welded joints provide an economical weld when full penetration is not required. Also, fillet welds can be used to reinforce groove welds. These applications are illustrated in Figure 28-4-12.



a. Single Fillet

b. Single J Groove, Fillet Reinforced

Figure 28-4-12
Fillet Welds

Double Welded Joints

Joints that are prepared for welding on both sides are termed double welded joints. Such joints can be employed for fillet welds and for any of the groove welds. Double welded joints are typically used when material thickness exceeds 3/4 inch and both sides of the joint are accessible for welding. Weld symbols for double welded joints are given by Figure 28-4-7.

Double welded joints offer easier distortion control. Opposite sides of the joint can be alternately welded such that shrinkage stresses tend to work in opposite directions.

WELD JOINT FIT-UP

Weld joint fit-up refers to all the necessary steps to bring weld joint members into proper position for welding. It also includes cleaning of weld joint members to remove surface materials that could be detrimental to weld quality. Therefore, fit-up includes cleanliness, alignment, and backing or consumable inserts.

Cleanliness

The weld end preparations of joining members will have residue from the cutting or machining process employed to make the preparation. Shop dirt may settle on the members. Also, the members may oxidize at least slightly in normal atmospheric conditions. For these reasons, a cleaning step always immediately precedes bringing weld joint members into alignment for welding. This cleaning serves to remove surface materials that could be detrimental to weld quality.

The cleaning method selected is based on the conditions of the weld joint members and their base material types.

It may be as simple as a cloth wipe with a detergent cleaner followed by a rinse cloth wipe. It may be a complex pickling process. For most applications, cleaning methods listed in Table 28-4-1 will suffice. Course 30, Mechanical Inspection, discusses specific cleaning processes and their application.

Table 28-4-1
Typical Cleaning Methods for Weld Joints

Undesired Surface Condition	Cleaning Method
Oxides, Scale	light grinding or wire brush followed by hot alkaline wash and water rinse
Oil Grease	detergent wash, water rinse
Paint, Crayon, Ink	paint remover followed by detergent or solvent wash and water rinse
Grit, Dirt, Lint	detergent wash, water rinse

Alignment

Weld joint alignment has two purposes: to make a fit-up suitable for quality welding and to minimize distortion. As discussed in Module 28-1, physical restraints (e.g., clamps, fixtures, braces), holds the weld joint members to minimize distortion from welding stresses. These physical restraints are adjusted in concert with supports (e.g., tables, positioners, stands) to not only hold weld joint members but also to properly align them. Alignment typically involves compliance with specified values for root gap, offset and geometrical form such as runout, perpendicularity, angularity, straightness or parallelism. These types of features are illustrated in Figure 28-4-13.

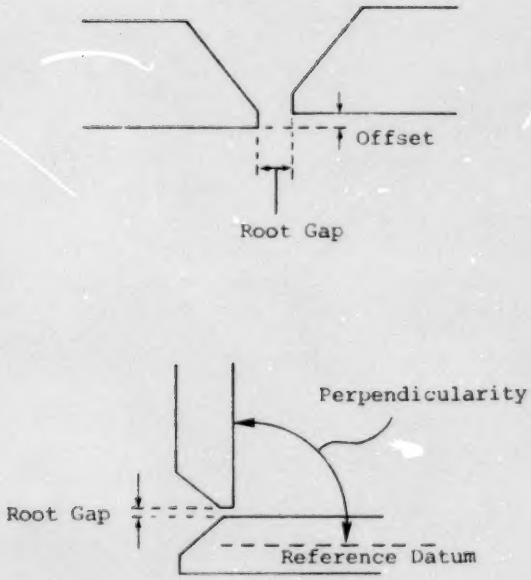


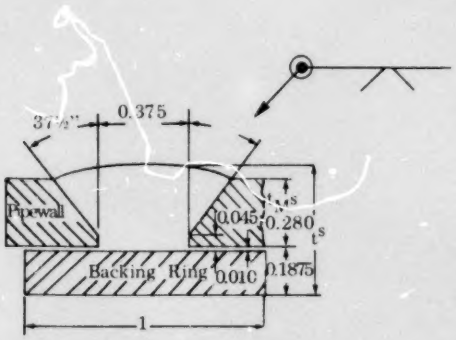
Figure 28-4-13
Alignment Features

Backing Strips and Rings

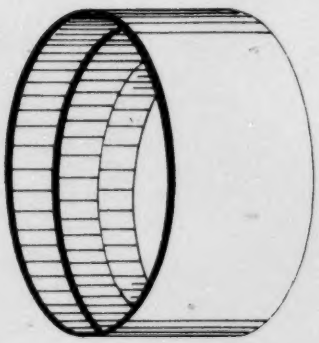
Backing strips or rings have the purpose of supporting the root weld layer for joints that can be welded from only one side. In those applications where high quality root welding is required but welding access to the reverse side is restricted, a backing strip (for plate) or backing ring (for cylinder and pipe) is fit-up to the joint. Such backing is normally of the same material as the base material of the joining members. A typical fit-up with a backing ring in a single V butt joint in pipe is shown in Figure 28-4-14.

Figure 28-4-14 gives a fit-up dimension of .010 inch for the annular gap between the outer diameter of the backing ring and the inner diameter of the pipe. This annular

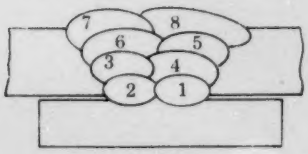
gap should be small in order to promote good penetration in both the joining members and the backing ring by the root welding passes (passes 1 and 2 in detail b).



a. Joint Design and Fit Up



c. As Welded Condition



b. Bead Placement and Sequence

Figure 28-4-14
Single V Butt Joint in Pipe with Backing Ring

It can be observed from Figure 28-4-14 that an open space (crevice) exists in the completed weld between the pipe and outer portions of the backing ring. This space can permit accumulation of sediments in service that may promote accelerated corrosion or unacceptable "hot spots"

if the deposit is radioactive. In addition, the presence of the backing ring does provide some restriction to fluid flow. Each case, therefore, must be evaluated and the correct fit-up and welding procedure must be followed to adhere to code requirements. Therefore, some applications require the removal of the backing ring after welding.

Consumable Inserts

Consumable inserts provide a method of obtaining crevice-free root welds for weld joints that cannot be welded from both sides. Where a backing ring is unacceptable because it cannot be removed as required to avoid crevices, a consumable insert provides a solution. Generally, backing rings are not used or allowed to remain in the stainless steel piping systems which carry radioactive liquids at a nuclear plant. Consumable inserts are used to avoid the development of "hot spots" from accumulated radioactive corrosion or erosion products flowing through the system.

Also, if crevices that are characteristic of socket welds are unacceptable, the consumable insert can be used. These applications are shown in Figure 28-4-15.

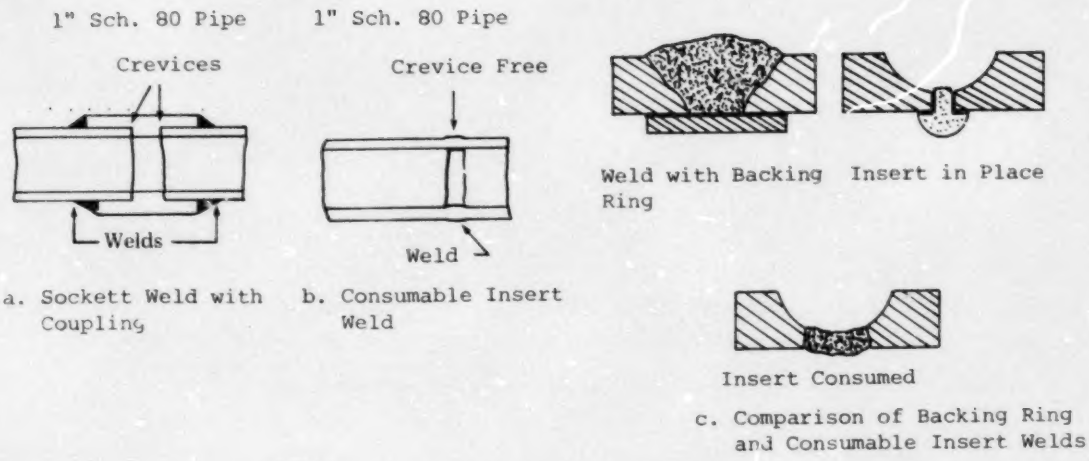


Figure 28-4-15
Application of Consumable Inserts

Gas Backing and Purge

For joints welded from only one side, the reverse side oxidizes if it is in a normal atmosphere. In many applications, this does not pose a problem. However, for piping in high pressure water systems such as the primary coolant system, oxidation of the reverse side can cause accelerated corrosion and lead to premature failure of the weld joint. For joints where reverse side oxidation is of concern but the reverse side is not accessible, shielding is applied to prevent the oxidation.

Reverse side shielding is accomplished with the same types of inert gases used in welding processes. To differentiate from that shielding, the term gas backing or purge is used for inert gases applied to the reverse side. Figure 28-4-16 illustrates a gas backing and purge set up.

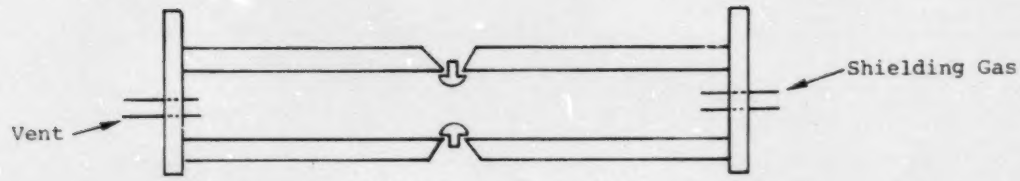


Figure 28-4-16
Gas Backing and Purge

When gas backing is required, the welding procedure specifies the gas type, amount of purge, and gas flow (or pressure). Prior to commencement of welding, the backing gas is directed through the pipe (or other component) for a time calculated to more than totally displace the atmosphere (normally at least twice as long). After displacement of the atmosphere, the inlet and outlet may be sealed (such as by closing valves in hose lines) and the flow stopped, or the gas flow may be continued for the duration of the welding.

VERIFICATION INSPECTION

Weld joint verification inspection confirms that specified requirements are met prior to commencement of welding. This verification inspection is primarily a visual inspection, although some dimensional inspection is necessary. The QA/QC technician normally performs this inspection. Acceptance criteria are either specified within the welding procedure or are referenced by it.

Weld joint verification inspection occurs at the point in time that the welder is making the fit-up immediately

prior to commencement of welding. At that point, the QA/QC technician confirms that welding may commence. This confirmation is based on the results of inspecting material identities, cleanliness, joint type, weld end preparation, fit-up, welding data, qualifications, and process controls. Module 28-6 discusses each of these in detail. Therefore, this module is limited to those inspections pertaining to joint type, weld end preparation, and fit-up.

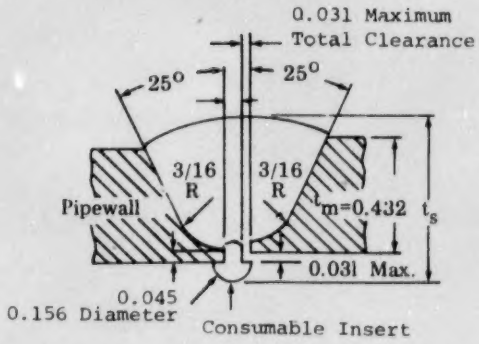
Welding procedures contain or reference sketches or drawings that specify joint type, weld end preparations, and fit-up. Details (a) and (b) of Figure 28-4-17 give typical sketches.

Visual inspection confirms joint type. As shown in detail (a) of Figure 28-4-17, the specified joint is of the butt type.

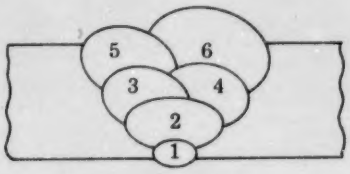
Weld end preparations are often dimensionally inspected at the time they are machined, and need only be visually inspected at fit-up. If dimensional inspection has previously been performed, the fit-up inspection visually observes for no damage to the weld end preparation. If dimensional inspection has not been performed previously, it is performed at fit-up inspection. For the joint shown in Figure 28-4-17, three dimensions would be inspected. These are the .045 inch land, the 3/16 inch J prep radius, and the 25^{o} included angle.

Fit-up dimensions are inspected at the time of weld joint verification inspection. For the joint shown in Figure 28-4-17, two fit-up dimensions are specified. These are the .031-inch maximum gap between the insert crown and pipe inner diameter, and the .031-inch maximum gap between the insert leg and the weld prep land. This latter gap is specified as a total clearance gap. This means that the gap can exist on one side of the insert leg or on both sides of the insert leg provided that the sum of the two

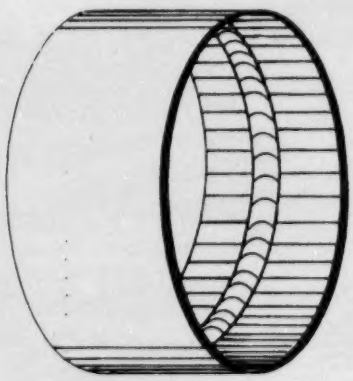
gaps does not exceed .031-inch. While geometrical form is not specified in Figure 28-4-17, the two fit-up dimensions could not be met if much misalignment were present.



a. Joint Design and Fit Up



b. Bead Sequence



c. As Welded Condition

Figure 28-4-17
Single U Groove Butt Joint in Pipe with Consumable Insert

SUMMARY

In summary, then, the following key points should be recalled:

a. Weld joint members are cleaned immediately prior to fit-up to remove surface materials that could cause porosity, inclusions, or incomplete fusion in the weld.

b. Weld joint members are aligned and held in position for welding by physical restraints such as clamps, fixtures and braces.

c. Fit-up dimensions typically include root gap, offset, and geometrical form.

d. Backing strips or rings support the root pass weld puddle.

e. Where crevices or excessive pressure drop in the pipe are not permitted, the backing ring must be removed.

f. A consumable insert becomes the root weld when it is consumed.

g. Consumable inserts permit making crevice-free welds when the reverse side is inaccessible.

h. The welding procedure and associated drawings and sketches specify special fixturing, fit-up dimensions, use of backing strip or ring or consumable insert, use of gas backing, and cleanliness requirements.

EXERCISES

Perform the following exercises as a means of reinforcing your knowledge of the material covered in this module.

1. Match the joint design with its description by placing the correct letter from the right-hand column with each definition in the left-hand column:

Definition	Joint Design
___ a. Joining members are placed side by side such that the end edge of one member forms a joint with the face of the other member.	(1) butt
___ b. Joining members are aligned along their longitudinal axes.	(2) tee
___ c. Joining members are placed side by side with their end edges in alignment.	(3) corner
___ d. Joining members are placed at right angles at their ends.	(4) lap
___ e. The end of one joining member is placed against the face of the other joining member to form a right angle.	(5) edge

2. List five types of weld joints in order of their relative strength, with the strongest joint listed first.

a. _____

b. _____

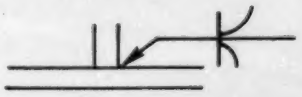
c. _____

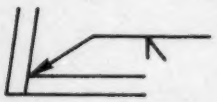
d. _____

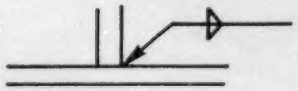
e. _____

3. Name the weld joint type and preparation represented by the following sketches and symbols:

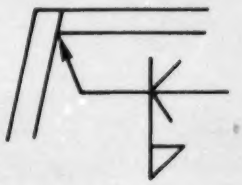
a.

b. 

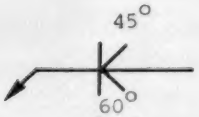
c. 

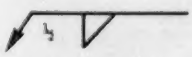
d. 

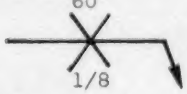
e.

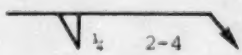
f. 

4. For the following welding symbols, state the meaning of the numerical values.

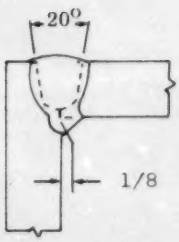
a. 

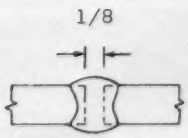
b. 

c. 

d. 

5. Sketch the welding symbol for the following weld joints.

a. 

b. 

6. Perform the inspection of welding qualification mock-ups as outlined in the PROCEDURES section of this module and collect the data specified.

7. Visit a welding shop and collect the data specified in the PROCEDURES section of this module.

MATERIALS

To avoid excessive trips to welding shops, the following materials are suitable for classroom training aids:

. plastic models of weld joints
. welding qualification mock-ups
. welding qualification test specimens

PROCEDURES

Laboratory/classroom exercises or field trips are recommended to permit students/trainees to inspect weld joints. Depending on local circumstances, weld joints may be accessible by any of the following methods:

. Welding shop within the institution
. Welding shop at a nearby vocational school

- Commercial welding shop
- Welding qualification mock-ups from nearby industries
- Plastic models of welding qualification mock-ups
- Nearby industry or nuclear power plant employing welding

1. Inspection of Welding Qualification Mock-Ups
   a. Students/trainees visually inspect each mock-up and complete applicable portions of Data Table 28-4-1.
   b. For each fit-up dimension contained by the mock-up, student/trainees state the purpose of the dimension on Data Table 28-4-1.
   c. For mock-ups containing backing strips/rings or consumable inserts, students/trainees describe the observable features of the backing insert on Data Table 28-4-1.

2. Visit to a Welding Shop
   a. Observe safety rules applicable to the welding shop.
   b. Each student/trainee select one welding operation and complete Data Table 28-4-1 by visually observing the weld joint.

DATA TABLE

Data Table 28-4-1

1. Sketch the weld joint configuration and fit-up based on visual inspection of a welding qualification mock-up

or a welding operation. Show joining members, weld end preparations, backing or inserts. Label key features.

2. Circle the proper entry below based on visual inspection of the mock-up or weld joint.

Type	Preparation	
Butt	Single	Squared
Tee	Double	Bevel
Corner		V
Edge		U
Lap		J
		Fillet
		Other (explain)

3. Backing Strip or Ring

Used Not Used

Description of condition, if used:

Uniformity of gap_____
Degree of weld penetration_____
Cleanliness of gap_____

4. Consumable Insert

Used Not Used

Description of condition, if used:

Uniformity of gap_____
Uniformity of insert melting_____
Convexity_____
Concavity_____

5. Gas Backing or Purge

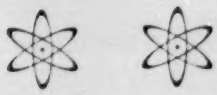
Used Not Used

Data, if used:

Gas type_____
Purge time_____
Gas flow_____

6. Fit-up dimensions (check applicable ones and enter their purpose):

Type of Dimension	Purpose
Root gap	_____
Backing strip or ring spacing	_____
Consumable insert spacing	_____
Geometrical Form (Specify_____)	_____
Offset	_____



REFERENCE MATERIALS

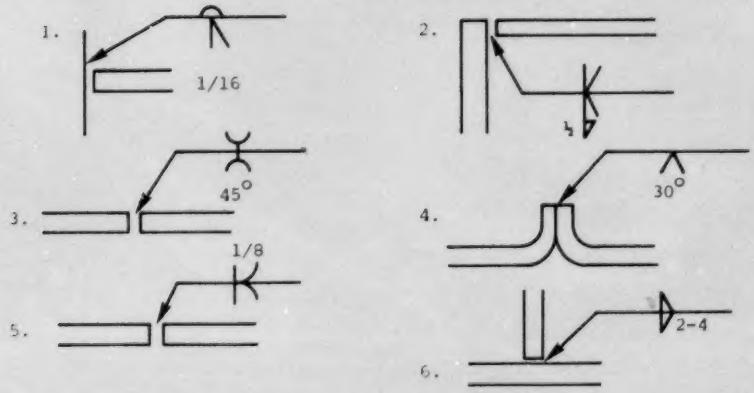
ASME, Boiler and Pressure Vessel Code, Section III, American Society of Mechanical Engineers, New York, N.Y. 10017

AWS, D1.1, Structural Welding Code, American Welding Society, 2501 N.W. 7th Street, Miami, Florida 33125.

ASM, Metals Handbook, Volume 6, Welding and Brazing, American Society for Metals, Metals Park, Ohio 44073.

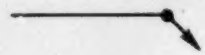
TEST

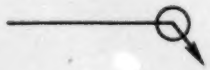
For each of the following sketches, name the weld joint type and preparation and state the meaning of the numerical values. Use the table following sketches to record answers.



Q	Type	Preparation	Meaning of Numerical Values
1			
2			
3			
4			
5			
6			

For each of the following supplementary weld symbols, state symbol's meaning.

7. 

8. 

9. List five types of weld joints in order of their relative strength (from highest to lowest).

10. State an advantage of single J groove compared to single bevel groove.

11. State an advantage of the V groove compared to squared weld joint.

12. State disadvantage of single J groove compared to single U groove.

13. State an advantage of double V groove compared to the single V groove.

14. State the reason for cleaning weld joint members prior to welding.

15. State the purpose of a backing ring.

16. Describe why a backing ring must be removed after welding in many applications.

17. State the purpose of a consumable insert.

18. Name three dimensional features that are normally specified for fit-up of weld joint members.

19. Describe how backing gas is beneficial to certain welding applications.

20. When backing gas is used, how is it known that the normal atmosphere has been completely displaced by the backing gas.

21. For the weld joint sketched below, list those dimensions pertaining to weld end preparation and those pertaining to weld joint fit-up.